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Committee on the Peaceful Uses of Outer Space

Report on the United Nations/South Africa Symposium on Basic Space Technology: Small Satellite Missions for Scientific and Technological Advancement

(Stellenbosch, South Africa, 11–15 December 2017)

I. Introduction

1. The United Nations/South Africa Symposium on Basic Space Technology: Small Satellite Missions for Scientific and Technological Advancement was the fourth in a series of international symposiums on basic space technology development to be held in each of the regions served by the Economic Commission for Africa, the Economic and Social Commission for Asia and the Pacific, the Economic Commission for Latin America and the Caribbean, and the Economic and Social Commission for Western Asia. The symposiums are part of the Basic Space Technology Initiative, which is carried out as part of the United Nations Programme on Space Applications. The Initiative is aimed at supporting capacity-building in basic space technology and promoting the use of space technology and its applications for peaceful purposes and in support of sustainable development.

2. The Symposium was organized by the Office for Outer Space Affairs of the Secretariat and, on behalf of the Government of South Africa, the Department of Science and Technology and the Department of Trade and Industry and the South African National Space Agency. The Symposium was hosted by Stellenbosch University.

3. The present report describes the background, objectives and programme of the Symposium, summarizes the presentations made during its technical sessions and panel discussions, and sets out the recommendations and observations made by the participants. The report has been prepared pursuant to General Assembly resolution 72/77. It should be read in conjunction with the reports on the three United Nations/Austria/European Space Agency symposiums on small-satellite programmes held between 2009 and 2011 (A/AC.105/966, A/AC.105/983 and A/AC.105/1005), the report on the United Nations/Japan Nanosatellite Symposium (A/AC.105/1032), the report on the United Nations/United Arab Emirates Symposium on Basic Space Technology (A/AC.105/1052) and the report on the United Nations/Mexico Symposium on Basic Space Technology (A/AC.105/1086).

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A. Background and objectives

4. The United Nations Programme on Space Applications was launched as a result of discussions at the first United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE), held in Vienna in 1968. The Programme is implemented by the Office for Outer Space Affairs and provides support to all States Members of the United Nations that wish to build capacity in space technology, regardless of their level of economic development. The initial focus of the Programme was on the applications of space technology in, for example, satellite communications, Earth observation and positioning and navigation services.

5. Advances in technology and the acceptance of a higher but still reasonable level of mission risk have resulted in increasingly capable small satellites that can be developed by academic institutions, research centres and similar organizations that have limited infrastructure and budgets for space activities. Many benefits can be derived from the development of small satellites, which has increased interest in establishing basic capacities in space technology development, including in developing countries and in countries that had, to date, been using space applications developed by others.

6. In response to that interest, the Basic Space Technology Initiative was added to the United Nations Programme on Space Applications in 2009. Pursuant to General Assembly resolution 37/90, the Programme should stimulate the growth of indigenous nuclei and an autonomous technological base, to the extent possible, in space technology in developing countries, with the cooperation of other United Nations entities and/or Member States.

7. The Initiative focuses on the development of affordable small satellites with a mass less than 150 kg and on the associated technical, managerial, regulatory and legal issues. It supports capacity-building in basic space technology and its applications for the peaceful uses of outer space in support of sustainable development and, in particular, addresses the contribution of basic space technology to the UNISPACE+50 process and implementing the "Space2030" agenda.

8. The Basic Space Technology Initiative began with the organization of three United Nations/Austria/European Space Agency symposiums on small-satellite programmes held in 2009, 2010 and 2011, followed by the current series of international symposiums, which started in 2012. The theme of the United Nations/Japan Nanosatellite Symposium, held in 2012, was "Paradigm shift: changing architecture, technologies and players". The theme of the United Nations/United Arab Emirates Symposium on Basic Space Technology, held in 2013, was "Small-satellite missions for developing space nations". Finally, the theme of the United Nations/Mexico Symposium on Basic Space Technology, held in 2014, was "Making space technology accessible and affordable".

9. The United Nations/South Africa Symposium had the following main objectives:

(a) Review the status of capacity-building in basic space technology for small satellites, including lessons learned from the past and ongoing development activities with a focus on regional and international collaboration opportunities, in particular for countries in Africa;

(b) Examine issues relevant to the implementation of small-satellite programmes, such as organizational capacity-building, development and testing infrastructure and launch opportunities;

(c) Review state-of-the-art scientific applications of small-satellite programmes and their associated supporting technological developments, with a particular focus on applications for the monitoring of agriculture, the environment and cities, and education to promote a sustainable growth, in line with the 2030 Agenda for Sustainable Development;

(d) Discuss regulatory issues relating to space technology development programmes, such as frequency allocation and space debris mitigation measures for enhancing the long-term sustainability of outer space activities and import and export controls;

(e) Discuss legal issues and responsibilities related to space technology development programmes, such as those arising from international space law;

(f) Discuss the way forward for the Basic Space Technology Initiative and its capacity-building and international cooperation activities in preparation for UNISPACE+50.

10. The Committee on the Peaceful Uses of Outer Space endorsed at its fifty-ninth session seven thematic priorities for UNISPACE+50 (see A/71/20, para. 296). The discussions at the Symposium will inform the preparations for UNISPACE+50, which will be held in 2018 to mark the fiftieth anniversary of the first United Nations Conference on the Exploration and Peaceful Uses of Outer Space in 1968. The observations and recommendations of the Symposium will contribute to the UNISPACE+50 process and will be brought to the attention of relevant policy and decision-making bodies.

11. The objectives of the Symposium reflected the aim of the Basic Space Technology Initiative and of the series of associated events related to thematic priority 7 ("Capacity-building for the twenty-first century"). The Symposium also covered activities supporting other thematic priorities, such as:

(a) Thematic priority 1 ("Global partnership in space exploration and innovation"), by promoting international collaboration and cooperation activities;

(b) Thematic priorities 2 ("Legal regime of outer space and global space governance: current and future perspectives") and 3 ("Enhanced information exchange on space objects and events"), by supporting small-satellite missions and raising awareness of the regulatory issues involved having to do with frequency allocation, the registry of space objects, space debris mitigation measures, import and export controls and other legal responsibilities;

(c) Thematic priority 6 ("International cooperation towards low-emission and resilient societies"), by reviewing the role of small satellites in sustainable and resilient cities and societies, and assessing their potential for Earth observation.

B. Attendance

12. The Symposium was attended by 126 space professionals involved in nanosatellite and small-satellite missions from governmental and intergovernmental institutions, universities and other academic entities, and by representatives of the private sector from 33 countries, namely Brazil, China, Costa Rica, Egypt, Ethiopia, France, Germany, Ghana, India, Indonesia, Japan, Kenya, Malawi, Mauritius, Morocco, Namibia, the Netherlands, New Zealand, Nigeria, Pakistan, Peru, the Russian Federation, Singapore, Slovakia, South Africa, Spain, the Sudan, Tunisia, Turkey, Uganda, the United Arab Emirates, the United Kingdom of Great Britain and Northern Ireland, and the United States of America.

13. The Symposium was co-sponsored, on behalf of the Government of South Africa, by the Department of Science and Technology, the Department of Trade and Industry, the South African National Space Agency and Stellenbosch University, as well as by the European Space Agency. Funds allocated by the United Nations and the co-sponsors were used to sponsor 31 funded participants. The sponsors also provided funds for the cost of organizing the Symposium and providing facilities, and for the local transportation of all participants.

C. Hands-on workshop before the start of the Symposium

14. As a pilot project, a two-day hands-on workshop was held with Nihon University and the University Space Engineering Consortium-Global (UNISEC-Global) on assembling picosatellites. The objectives were to enhance participants' understanding of basic satellite system architecture, let them experience the process of developing a picosatellite, have them gain experience with space systems engineering by having them assemble, integrate and test a HEPTA-Sat picosatellite kit and train them so that they could lead similar workshops in the future.

15. The workshop was attended by 18 space researchers and students involved in nanosatellite and small-satellite missions. The attendants represented governmental institutions as well as universities and other academic institutions from 11 countries, namely Brazil, Egypt, Ghana, Kenya, Mauritius, Namibia, the Netherlands, Nigeria, South Africa, the Sudan and Uganda. Together, they assembled six picosatellites.

16. The workshop was hosted and sponsored by Stellenbosch University. Nine international participants and two experts were sponsored by the United Nations.

II. Programme

17. The programme of the Symposium was developed by the Office for Outer Space Affairs, the Government of South Africa and Stellenbosch University, in cooperation with the programme committee of the Symposium. The programme committee included representatives of national space agencies, international organizations and academic institutions. An honorary committee and a local organizing committee also contributed to the successful organization of the Symposium.

18. The programme consisted of an opening session, keynote addresses, seven technical sessions, a panel discussion, a poster session and discussions on observations and recommendations, followed by closing remarks by the co-organizers.

A. Opening session

19. At the opening session, welcoming remarks were made by a representative of Stellenbosch University, the Chief Executive Officer of the South African National Space Agency, a representative of the mayor of Stellenbosch, the Deputy Director General of the Department of Science and Technology and a representative of the Office for Outer Space Affairs.

20. In the first keynote address, a representative of the Department of Science and Technology provided an overview of space science and technology in South Africa. He reviewed the history of his country's space activities, which included the establishment of the South African National Space Agency in December 2010, and presented the Agency's current policy and strategy.

21. The second keynote address was delivered by a representative of California Polytechnic State University, who explained the role of small satellites in workforce development and highlighted their contribution to the private sector and their role as a training tool for students.

22. Two introductory presentations were given by representatives of the Office for Outer Space Affairs, who focused on UNISPACE+50, the Basic Space Technology Initiative and the objectives of the Symposium. They were followed by a representative of Stellenbosch University, who gave an overview of the University's satellite projects over the past 25 years.

B. Technical sessions

23. Technical sessions were held on the following topics: (a) space technology development and capacity-building with a focus on Africa; (b) small-satellite missions in support of key scientific projects and questions; (c) applications of small-satellite missions; (d) small-satellite projects for engineering education; (e) regulatory and legal issues and long-term sustainability of outer space activities; (f) other aspects of small satellites; and (g) international experiences and opportunities, followed by a poster session.

1. Space technology development and capacity-building with a focus on Africa

24. A representative of the National Space Research and Development Agency of Nigeria (NASRDA) gave a historical overview of the country's space programme. NASRDA had been focusing on three satellite projects: NigeriaSat-1, launched in 2003; and NigeriaSat-X and NigeriaSat-2, both launched in 2011. It had also developed a geostationary satellite that had been built in partnership with China. The space programme of Nigeria had a strong focus on capacity-building and the transfer of know-how. NASRDA understood that its vision could be realized only through an intense programme of capacity-building, research and international cooperation.

25. The second presentation was given by the African Regional Centre for Space Science and Technology Education — in French Language (CRASTE-LF), affiliated to the United Nations. The objectives of the Centre were to develop educational material; to increase knowledge in space sciences and technologies by offering, at the regional level, postgraduate programmes and shorter courses such as seminars, workshops and conferences to improve the technical competence of experts, teachers and decision-makers; to assist the countries of the region in the development of their own capacity in space tools; to strengthen local and regional capacities; to promote cooperation between developed countries and States served by CRASTE-LF; and to develop expertise in space science and technology.

26. A representative of the Kenya Space Agency argued that CubeSats were a pathway to space for developing countries. This was illustrated by the first Kenya University nanosatellite-precursor flight (1KUNS-PF), to be launched in 2018, which consisted of a 1U CubeSat being developed by students from Kenya and Italy. The CubeSat was part of an international master's degree programme resulting from collaboration between the University of Nairobi and the University of Rome with the support of the Kenya Space Agency and sponsored by the Italian Space Agency. The 1KUNS-PF CubeSat was selected to be the first beneficiary of the KiboCube programme resulting from collaboration between the Office for Outer Space Affairs and the Japan Aerospace Exploration Agency (JAXA).

27. A representative of the South African National Space Agency gave a presentation on the development of space technology in South Africa and the numerous opportunities offered by the Agency for academia and private companies in the country to embark on space activities, and discussed the use of satellite information for socioeconomic development.

2. Small-satellite missions in support of key scientific projects and questions

28. The chief executive officer of New Space Systems introduced stellar gyroscope, a new type of sensor that offered a virtually driftless gyroscope function by using the image processing technology from a simple low-cost camera, making it possible to create low-cost communications constellations. The stellar gyroscope had been developed with support from the Aerospace Industry Support Initiative, which was managed jointly by the Department of Trade and Industry of the Government of South Africa and the Council for Scientific and Industrial Research.

29. A representative of the Space Advisory Company focused on the contribution of South Africa to the Netherlands-China lunar explorer, which will be the second lunar lander of China and humanity's first spacecraft to land on the far side of the Moon.

The goal is to perform astrophysical studies from translunar locations in the unexplored radio spectrum from 80 kHz to 80 MHz. The Netherlands-China lunar explorer mission is considered a pathfinder for a future low-frequency space-based or Moon-based radio interferometer.

30. A representative of JAXA introduced the two lunar CubeSats developed in his organization. Omotenashi and Equuleus had been selected as secondary payloads to the EM-1 mission of the National Aeronautics and Space Administration (NASA) of the United States. Omotenashi and Equuleus paved the way for future deep-space CubeSats and cargo vehicles to the cislunar region by demonstrating novel trajectory control techniques with limited fuel requirements.

31. A representative of the National Institute for Space Research of Brazil presented the results obtained with NanosatC-Br1, which had been launched in June 2014 and was still operational. He also spoke about the development of NanosatC-Br2, to be launched next year, and the strategy of the Institute to develop its nanosatellite programme, including payload assembly, integration and testing, on-board software development, operations and data distribution.

32. A representative of the University of Cape Town, South Africa, explained the importance of space-borne synthetic aperture radar using small satellites. Synthetic aperture radar was a mature technology with a diverse range of potential applications. It had advantages over the use of other electromagnetic wave spectrum frequencies, one of which was that it gave access to the whole surface of the Earth regardless of cloud cover.

33. A representative of Theia Space gave a presentation on his company's hands-on training satellite kit named ESAT, which showed users how various subsystems and architectures worked and how the process of integration and validation functioned.

3. Applications of small-satellite missions

34. A representative of the University of Erlangen-Nuremberg, Germany, gave an overview of how satellite-powered data analytics could be used to empower farmers. While satellite data had been used to monitor agriculture for the last three decades, the complex relationships between parameters governing crop growth and soil health had posed challenges limiting research in this field. The speaker proposed going beyond the traditional geographic information system techniques and using machine learning and parallel computing techniques to resolve those complex relationships and gain insights into crop phenology. He argued that there was a strong case for creating a disruptive technological solution for finance and governance.

35. A representative of the Mauritius Research Council introduced the MIRT-SAT1 proposal. He explained that Mauritius would be able to use CubeSats as a solution to current socioeconomic issues. MIRT-SAT1 was seen as a short- to medium-term solution, as it would be the first Mauritian infrared and telecommunication satellite to address various challenges. Additionally, the speaker mentioned that the KiboCube programme contributed to the development of the MIRT-SAT1 mission proposal.

36. A representative of Clyde Space highlighted the international partnership programme between Africa and the United Kingdom to enhance the detection of fires using nanosatellite technology. The project included a master's degree programme addressing some of the Sustainable Development Goals and illustrating the application of satellite applications. Earth observation, navigation and communications, data science, entrepreneurship and space systems were optional. The main aim was to encourage students to create new services and develop companies. The programme would be available as of September 2019. A joint PhD programme is also available.

37. A representative of HEAD Aerospace Group presented the HEAD-1 Satellite, which provided in-orbit operational data for maritime surveillance. She indicated that the company was planning to create a constellation of 30 small satellites equipped

with Automatic Identification System receivers and hyperspectral sensors. The applications would include real-time maritime surveillance services.

38. The technical session concluded with a presentation entitled "Enabling the blue economy through spatial information systems", given by a representative of the Council for Scientific and Industrial Research of South Africa. The speaker mentioned the Operation Phakisa project, which was aimed at improving the use of oceans for socioeconomic development.

4. Small-satellite projects for engineering education

39. A representative of the Department of Science and Technology of South Africa presented the objectives of the Pan-African University, its thematic principles and partners. The University is a continental network of academic, research and innovation institutions. It is composed of five hubs located in different regions of Africa. Its purpose is to develop African institutions of excellence in science and technology, enhance African postgraduate education and promote integration and cooperation in Africa through the mobility of talented and qualified applicants.

40. A representative of Nanyang Technological University of Singapore gave a general overview of the small-satellite missions developed at the University's Satellite Research Centre, its past missions, future projects and international collaboration programmes. The Centre had developed seven satellites. The most noted was the first satellite built in Singapore, XSAT, which was developed and launched in 2011. The Centre had established strategic collaboration programmes with local and international organizations that provided training opportunities for students at the undergraduate, graduate, middle and high school levels.

41. A representative of the Cape Peninsula University of Technology of Cape Town, South Africa, gave a general description of the University's satellite programme and its national and regional perspectives. The programme had led to the launch of Africa's first CubeSat, in 2013, and to the current development of Africa's second nanosatellite, to be launched in 2018. It had also resulted in the establishment of local, regional and global cooperation programmes and a proposal to design and implement a constellation of African nanosatellites.

42. A representative of the University of Auckland presented the CubeSat programme of New Zealand, the results obtained through it and its future perspectives. The programme was targeted at undergraduate students of all faculties of the University, with multidisciplinary teams potentially creating synergies. The Auckland programme for space systems was to have a CubeSat ready for launch at the end of 2018. It is to become the first satellite built in New Zealand to go into space. The programme is intended to create opportunities for students, encourage leadership and become an incubator for start-ups.

43. A representative of All Nations University of Ghana gave a comprehensive description of the main projects developed at its Space Science Technology Laboratory, its CubeSat programme and its future perspectives. The Laboratory had developed various educational programmes. The most attention was given to GhanaSat-1, a 1U CubeSat that was launched successfully from the International Space Station (ISS) in July 2017. GhanaSat-1 was the first satellite Ghana had launched into space. The country's goal for the future was to develop a GhanaSat-2 satellite to monitor illegal mining activities and the water pollution that affects Ghana.

44. A representative of Nihon University, Japan, gave an overview of its HEPTA-Sat hands-on picosatellite training kit, its main parts and stressed the importance of training on new space systems engineering. The HEPTA-Sat kit introduced students to the basic concepts of assembly, integration and testing. The hands-on training format enabled students to experiment, solve problems, design missions and receive feedback from specialists.

45. A representative of the University of Carthage of Tunisia presented the Sup'Com space programme, its strategies and its challenges. Sup'Com had

established regional and international forms of cooperation with space technology institutions and universities.

46. A representative of the Space and Upper Atmosphere Research Commission of Pakistan presented his country's national student satellite programme for space engineering education, its objectives, its current development status and the lessons learned so far. The aim of the programme was to establish collaboration between the Space and Upper Atmosphere Research Commission and academia. The programme started in 2012 with hands-on training for students. Among its achievements was the development of a functional microsatellite, PNSS-1, different modules of which were managed by different universities. Integration and testing was the next step.

5. Regulatory and legal issues and long-term sustainability of outer space activities

47. The Chief of the Committee, Policy and Legal Affairs Section, of the Office for Outer Space Affairs presented the international legal regime and governance aspects of outer space activities. He gave an overview of the countries that had ratified the five United Nations space treaties, focusing on African countries and their participation in international space governance. The speaker also highlighted new items on the agenda of the Legal Subcommittee of the Committee on the Peaceful Uses of Outer Space.

48. A representative of the Office for Outer Space Affairs introduced the questionnaire on the application of international law to small-satellite activities, which had been adopted by the Legal Subcommittee in 2017 (see A/AC.105/1122, appendix II). It covered six main areas, entitled "Overview of small-satellite activities", "Licensing and authorization", "Responsibility and liability", "Launching State and liability", "Registration" and "Space debris mitigation in the context of small-satellite activities". In addition, the speaker discussed frequently observed legal and regulatory issues related to small-satellite activities.

49. A representative of the African Regional Centre for Space Science and Technology Education — in English Language, affiliated to the United Nations, discussed legal issues and responsibilities related to space technology development programmes and the need for African countries to create more national space policies and laws on space activities. He provided participants in the Symposium with a detailed overview of some pressing legal and regulatory matters associated with space activities, such as radio frequency management, national legislation and authorization.

50. The Chief Director of Space Affairs at the Department of Trade and Industry of South Africa discussed her country's legal and regulatory framework on small-satellite activities and its proposed amendments, starting with the Space Affairs Act of 1993 and including current draft legislation.

51. The Chair of the Working Group on the Long-term Sustainability of Outer Space Activities summarized the status quo of the discussions held at the Committee on the Peaceful Uses of Outer Space regarding long-term sustainability. Following the acceptance of an initial set of long-term sustainability guidelines in 2016, the progress achieved in 2017 was limited mainly to the preparation of the preambular text. Several guidelines still remained under consideration as of December 2017, including one proposed guideline focusing on small-satellite activities.

52. Small-satellite radio frequency spectrum issues was the topic of a presentation made by a representative of the Department of Telecommunications and Postal Services of South Africa. He primarily addressed the existing international regulatory framework governing frequency spectrum management and gave a general overview of existing regulations within the International Telecommunication Union (ITU) regime applicable to small-satellite missions. The speaker emphasized that actors had to act through their national authorities, as ITU only accepted applications from appointed State representatives.

53. A representative of ITU conducted a workshop on frequency registration for small-satellite missions. He explained the procedure for frequency registration through ITU SpaceCap and stressed the importance of notifying and recording the use of frequency bands by small-satellite systems in accordance with the ITU Radio Regulations.

6. Other aspects of small-satellite activities

54. A representative of the National Institute for Space Research of Brazil discussed the growing concern at the accumulation of objects in orbit. He described a new concept of de-orbiting techniques that use solar radiation pressure and atmospheric drag to force the decay of a body in orbit. The new technology used a variable area, such as an inflatable balloon, and a variable coefficient of reflectivity, and could accelerate the decay time for different types of orbits.

55. A representative of the Ghana Space Science and Technology Institute addressed the CubeSat development programme of his country, which was devoted to monitoring illegal gold mining activities using hyperspectral imagery. The programme included the design of a ground control segment for CubeSats by converting an existing antenna. In addition, the programme was expected to aid in resolving other countries' environmental and risk management issues, and in developing technical capacities in space technology.

56. A representative of the Space Advisory Company shared details of the satellite tracking ground station for the nSight-1 CubeSat mission. He addressed hardware and software design from the project perspective. Using readily available off-the-shelf components, the mission could benefit other institutions interested in establishing their own satellite-tracking capabilities.

57. A representative of the DFH Satellite Company discussed integration technology on microsatellites and nanosatellites for high-performance remote sensing. He addressed the need for higher space and time resolution at a lower cost, and illustrated how optical design could be innovated through miniaturization and integration. The presenter concluded that a revolution in big data from satellites, making them accessible and available at a low cost, could benefit countries with emerging space capabilities.

58. A representative of the Federal Institute of Education, Science and Technology of Brazil presented a system of data collection based on automated weather stations located all across Brazil that were linked to ground stations by satellite. The system currently covered 10 per cent of the country and was scheduled to scale up to become a global community based on data-sharing. The success of the project relied on the support of various institutions and had resulted in a successful spin-off company. A Brazilian satellite data transmitter had been developed to work with satellite constellations and the data could be accessed through a platform developed specifically for that purpose. The speaker took the opportunity to introduce the United Nations/Brazil Symposium on Basic Space Technology, to be held in Natal, Brazil, in 2018.

7. International experiences and opportunities

59. A representative of JAXA reported on the KiboCube programme conducted in cooperation with the Office for Outer Space Affairs, with a second CubeSat recently selected for deployment. JAXA had deployed over 200 public and private sector satellites using the Kibo module of ISS. The satellites are deployed in a down-backward fashion to avoid collision with ISS. The speaker mentioned that capacity-building and providing support to educational institutions had been the main goals of the KiboCube programme. As part of its cooperation with the Office, JAXA was providing opportunities to entities in developing countries to deploy their satellites from ISS. In addition, he invited applications for the third round of the KiboCube programme by the deadline of 31 March 2018.

60. A representative of UNISEC-Global explained that the organization was structured as a non-governmental organization with 15 country chapters worldwide and had been granted permanent observer status at the Committee on the Peaceful Uses of Outer Space in 2017. The speaker discussed the UNISEC-Global CanSat Leader training programme, which had benefited 73 participants from 34 countries since its inception in October 2010. The goal of UNISEC-Global was to promote the development of practical space projects in every country in the world by 2030 as one way to achieve the Sustainable Development Goals.

61. A representative of SCS Aerospace Group provided an overview of the SUNSAT programme in South Africa. SUNSAT was launched in 1999 and led to exchanges with NASA on the programme's battery supply, provided opportunities for visiting students from Europe and formed the basis for the development of the imager used in the Kitsat-3 satellite of the Republic of Korea. SUNSAT was followed by SumbandilaSat launched in collaboration with the Russian Federation. The speaker explained that the African resource management constellation promoted capacity-building activities and international collaboration among African countries and expressed his view on the willingness that existed to follow up with nSight-2 and nSight-3 to continue the current international collaboration and capacity-building activities.

62. A representative of Kyutech presented the BIRDS satellite project, the aim of which was to train students from developing countries on satellite design and manufacturing to enable their countries to set up a sustainable space programme. The BIRDS satellites, which fostered a human network of trained students from developing non-spacefaring countries, won the 2017 GEDC Airbus Diversity Award for this mission.

8. Poster session

63. Poster presentations were made by 20 participants from Brazil, China, Costa Rica, Egypt, Ethiopia, Ghana, Japan, Kenya, Malawi, Namibia, the Netherlands, Nigeria, Peru, Slovakia, South Africa, the Sudan, Uganda and the United Arab Emirates. The posters covered topics of scientific research, political analysis, economical growth and applications related to small-satellite activities.

C. Panel discussions

64. A panel discussion on young African space engineers in the global space arena was held, focusing on the available opportunities and main challenges.

65. In their discussions, the moderator and panellists from Egypt, Ghana, Kenya, Nigeria and South Africa discussed the opportunities and challenges for young African space engineers, covering the areas of industry and education and the topics of the cost of satellite missions and African collaborative satellite projects.

III. Observations and recommendations

66. With regard to capacity-building and international cooperation in space technology development:

(a) The participants in the Symposium noted that the African continent has a high potential for growth in the field of small satellites and can significantly benefit from an increase in the local development of satellites and use of satellite applications for social and economic development;

(b) The participants noted that space science and technology is an important tool for ensuring the sustainable use of natural resources, fostering entrepreneurship and the creation of high-technology industrial sectors. Furthermore, it makes a considerable contribution to the creation of enabling environments in which a wide

range of pressing challenges can be addressed, including the need to create jobs, reduce poverty, manage resources in a sustainable manner and develop rural areas. A formal space sector will assist Africa to realize the vision of a peaceful, united and prosperous continent;

(c) Recognizing these needs, the participants recommended that the Office for Outer Space Affairs create platforms for partnerships and capacity-building specifically dedicated to Africa, following hands-on training models such as HEPTA-Sat, KiboCube and UNISEC-Global in Africa;

(d) The participants welcomed the information that the United Nations/Japan Long-term Fellowship Programme on Nanosatellite Technologies, conducted in collaboration with the Kyushu Institute of Technology, was extended for the period 2018–2020. This was seen as an important opportunity for African academic institutions to further develop their capabilities in basic space technology and its applications;

(e) The participants acknowledged that African research councils and academia are collaborating on, among other things, the reception and dissemination of fire monitoring data and maritime domain applications;

(f) The participants recommended increasing efforts to raise awareness of the potential of small-satellite programmes for capacity-building, education, the provision of Earth observations data and telecommunication services, and technological development. The participants also recommended further consideration by African universities of a coordination mechanism for the development and operation of a constellation of CubeSats;

(g) In this regard, the participants acknowledged the necessity for increased opportunities for women in the education fields of science, technology, engineering and mathematics, in particular in space science and technology;

(h) The importance of stronger cooperation between Governments, intergovernmental and non-governmental organizations, the private sector, academia and research institutions was noted. The development of a Pan-African University network for space science and technology was encouraged. It was also recommended that a young African space dialogue be established, to be recognized by decision-making bodies such as the Pan-African Parliament and the African Union Commission;

(i) To further enhance long-term space capabilities at the national and regional levels, the educational programmes of the African regional centres for space science and technology education, affiliated to the United Nations, should be strengthened and fully utilized. The African regional centres were also encouraged to take a proactive role in building an alliance of all regional centres;

(j) The participants acknowledged the efforts of the Office for Outer Space Affairs to promote better access to space and to bridge the space divide, by enhancing access to space-based data and information and future opportunities for ground, launch and in-orbit experiments and research, as well as through the design, manufacturing and operation of small satellites;

(k) It was noted, in this regard, the importance of facilitating access to orbit for developing countries and emerging space nations, through, for example, the KiboCube programme in cooperation with JAXA. The participants encouraged the Office and potential partners to extend these opportunities to larger CubeSats, or to more than one CubeSat per year;

(l) The participants considered that in an effort to strengthen the African contribution to global governance of outer space activities, more African countries should become active members of the Committee on the Peaceful Uses of Outer Space. The Group of African States should also increase its active participation in the work of the Committee. In this regard, the participants noted the progress made in the

preparations for UNISPACE+50 under its thematic priority areas, and the opportunity to support the objectives of the African Space Policy and Strategy;

(m) In this context, the participants noted with satisfaction that the General Assembly, in its resolution 72/77 on international cooperation in the peaceful uses of outer space, welcomed the adoption of the African Space Policy by the Assembly of the African Union at its twenty-sixth ordinary session, held in Addis Ababa on 30 and 31 January 2016, and noted that this achievement marked the first step towards the realization of an African outer space programme within the framework of Agenda 2063 of the African Union;

(n) It was suggested that the African Union should consider seeking permanent observer status with the Committee on the Peaceful Uses of Outer Space to foster the African common interest in international cooperation in the peaceful uses of outer space;

(o) The participants welcomed the Legal Subcommittee questionnaire on the application of international law to small-satellite activities, covering licensing and authorization, responsibility and liability, launching State and liability, registration and space debris mitigation, and recognized its importance in raising awareness among States and the potential for sharing good practices related to small-satellite activities. States members and permanent observers of the Committee were encouraged to respond to the questionnaire;

(p) Participants encouraged African countries to develop their own space policies and strategies. This policy framework will guide and inform the ratification of United Nations treaties on outer space, and in particular, promote the universality of the Outer Space Treaty;

(q) The participants noted with appreciation the explanation on the regulatory procedure for submitting frequency registration through the ITU SpaceCap tool and recognized the importance of notifying and recording the use of frequency bands by small-satellite systems, in accordance with ITU Radio Regulations. The participants noted that the "Guidance on space object registration and frequency management for small and very small satellites", published by the Office for Outer Space Affairs and ITU, served as useful guidelines for Governments and small-satellite operators;

(r) The participants noted the importance of facilitating access to orbit for developing countries and emerging space nations. Small satellites with short-duration missions were becoming the means for such countries to become involved in space activities. A simplified regulatory regime for the coordination, notification and recording procedures for frequency assignments pertaining to small-satellite networks with short-duration missions was required, taking into account the short development cycle, the short lifetimes and the typical missions of such satellites;

(s) The participants suggested having in future symposiums a dedicated session focusing on space debris mitigation and end-of-life disposal, in accordance with the Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space;

(t) The participants noted that the guidelines for the long-term sustainability of outer space activities being developed by the Committee on the Peaceful Uses of Outer Space would provide helpful guidance for governmental and non-governmental entities involved in the development and operation of small satellites. The participants further noted that the implementation of these voluntary guidelines would strengthen governance and enhance the safety, security and sustainability of outer space activities;

(u) The participants in the pilot HEPTA-Sat workshop, which was held back-to-back with the Symposium, expressed their appreciation for the hands-on activities conducted in connection with the present symposium. A hands-on workshop for a limited number of participants should in the future become an integral part of the

symposiums, which could cover educational satellite kits, FlatSats, software platforms and data analysis, among other things;

(v) The participants recommended that the Office of Outer Space Affairs should be actively involved in and keep abreast of developments in the small-satellite community by participating in, and when possible sponsoring, cooperation projects and activities and by attending relevant events such as the Annual Small Satellite Conference and the Annual CubeSat Developers Workshop;

(w) The participants expressed their appreciation to the organizers of the Symposium for the multidisciplinary and cross-sectoral nature of the symposium programme, which addressed the discipline of small satellites in a holistic manner;

(x) The participants recognized the significance of the Basic Space Technology Initiative of the Office for Outer Space Affairs and recommended that the series of symposiums on basic space technology be continued, covering the regions of the economic and social commissions of the United Nations. In that regard, the participants welcomed and endorsed the proposal of Brazil to host the next symposium in 2018, with a focus on Latin America and the Caribbean.

IV. Conclusions

67. The next symposium on basic space technology will focus on capacity-building in space technology development for Latin America and the Caribbean. Representatives of institutions of the following countries have expressed an interest in hosting a future regional workshop on basic space technology development in the period 2019–2020: Lebanon, Pakistan, Russian Federation and United States.